PATENT SPECIFICATION

(11) 1 400 477

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(21) Application No. 44200/72 (22) Filed 25 Sept. 1972

(31) Convention Application No. 208 318

(32) Filed 15 Dec. 1971 in

(33) United States of America (US)

(44) Complete Specification published 16 July 1975

(51) INT CL² H04Q 9/00

(52) Index at acceptance

G4H 12G 13D 13F 14A 14B 14G 1X 23D 6A 6B 6D 7A3 7B 7D 8B 8D NB NC2

(19)

(54) IMPROVEMENTS IN OR RELATING TO REMOTE DATA READING SYSTEMS

(71) We, NORTHERN ILLINOIS GAS COMPANY of East-West Tollway at Route 59, Aurora, Illinois, 60507, United States of America, a corporation organised and existing under the laws of the State of Illinois, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to systems for effecting selective readout of data from a plurality of data indicating devices disposed at different locations.

Various systems have been proposed in the prior art for obtaining information from a plurality of remote sources. For example, remote reading systems have been employed to effect the readout of a plurality of utility meters from a central interrogation station which may be mobile or stationary.

In such systems, interrogate data signals generated at a central location are transmitted to a plurality of data indicating devices at locations remote from the central location to effect readout of information provided at such locations. Each data indicating device has associated therewith a transponder for receiving the interrogate data signals and for generating reply data signals representing the information provided by the indicating device for transmission back to the central location.

Some prior art remote reading systems employ RF communication links to enable the transmission of data between the central location and the transponders associated with indicating devices at the remote locations. Such systems require an RF signal antenna at the central location as well as at the location of the transponders at the remote locations. Since the indicating devices being read out are generally located within a building, the signal antennas at such remote locati ns must be located outsid the buildings to enable reception of interrogate data signals transmitted from the central location and the transmission of reply data signals back to the central location. Accordingly, a separate signal line must be extended from the location of each transponder unit within the building to the location of the antenna at the outside of the building.

In other systems the interrogate data signals are transmitted over communication links established over a telephone line connected between the central location and the transponders at locations remote from the central location. However, such systems can be employed only where a telephone line is available at the location of the indicating device and associated transponder.

Thus, in either of these prior art systems, it is generally necessary to provide a separate data communication line between the locations of an indicating device in a building and a point in the building from which the data can be transmitted to a central interrogate station. In applications wherein a plurality of indicating devices are located at different locations within a given building, the requirement of providing the necessary data communication lines may add considerable cost to the system.

According to the present invention, there is provided a system for effecting selective readout of data from a plurality of data indicating devices disposed at respective different locations, comprising interrogate means for generating interrogation signals selectively coded in accordance with a selected one of the data indicating devices which is to be read out, control means disposed at a control location and including a first means responsive to the interrogation signals to provide control signals for effecting the readout of a selected indicating device and signal coupling means for coupling the control signals to an electrical power supply line, and a plurality of trans-

ponders each connected to the power supply line and to a respective one of the data indicating devices, the transponders each being responsive to receipt of control signals coded to select the associated data indicating device to apply to the power supply line, for transmission to the control location, data signals representing a readout of the device, the control means including a second means responsive to said data signals to generate reply signals representing the readout for transmission to the interrogate means.

Using an existing electrical power supply line eliminates the need to provide a separate data communication line between the locations of the indicating devices and the control means.

In one embodiment of the invention disclosed hereinbelow the interrogate means is disposed at the control location.

In another embodiment, also disclosed hereinbelow, the interrogate means is disposed at a central interrogate station remote from the control location, the interrogation and reply signals being transmitted between the interrogate means and the control means by way of a communications link. The link may be a radio link, in which case the interrogate means may be mobile, or it may be a line, for instance a telephone line.

In one of the said embodiments there are a plurality of said control means each disposed at a respective one of a plurality of control locations, the interrogate means being connected with each of the control means by a respective one of a plurality of communication links.

In both embodiments, each indicating device has associated therewith an encoder for converting the reading of the indicating device into binary coded signals and the transponder is responsive to the control signals provided by the control means to generate the data signals which are coded to represent the reading data provided by the encoder. The control signals provided by the control means are transmitted over the power line to all of the transponders that are connected to the power line. The indicating devices may be located within the same building, and in such case, the existing electrical power lines of such building are used as a data transmission line between the indicating devices and the control means.

The various signals may be generated and processed, in the various parts of the system, in binary digital form, though the control signals and data signals are preferably converted to frequency modulated form for transmission over the power line, to provide a high system signal-to-noise ratio in the presence of impulse noise signals on the power line.

Duplex operation is afforded, in a preferred arrangement, by using different carrier frequencies for the control signals and the data signals.

In the above-mentioned embodiment of the invention in which the readout of a plurality of groups of data indicating devices is controlled from a central interrogate location, each group of data indicating devices may be located in a different building and a separate control means may be provided for each building. For transmission over the communications link, the binary digital form interrogate and reply signals may be converted to multi-frequency form, when the communications link is a line, or into RF form, when the link is a radio link.

The invention will be more readily understood from the following description, given by way of example only, of the above-mentioned embodiments thereof. The description refers to the accompanying drawings, in which:

Figure 1 is a block diagram of a system for providing readout of a plurality of indicating devices at different locations from a control unit at a location remote from the locations of the indicating devices wherein digital data is transmitted between the locations of the indicating devices and the control unit over existing electrical power lines;

Figure 2 is a timing chart illustrating a readout cycle for the system shown in Figure 1;

Figure 3 is a schematic circuit diagram of a signal coupling network for connecting a control unit and a plurality of transponders of the system shown in Figure 1 to a common electrical power line;

Figure 4 is a block diagram of another system for providing remote readout of a plurality of groups of indicating devices from a central location; and

Figure 4*a* is a schematic representation of a mobile interrogate unit for use with the system shown in Figure 4.

Referring to Figure 1, there is shown a block diagram of a system 20 for controlling the readout of a plurality of data indicating devices 21—23 from a central location. Th system includes a control unit A at the central location and a plurality of transponders including transponders A1, A2, . . . AN shown in Figure 1, each individually associated with a different one of the indicating devices 21—23.

The data indicating devices 21—23 may be register counters of business machines, such as copying machines which register the number of copies made by the machines, multi-dial registers of utility meters which indicate an amount of a commodity used, or any type of storage or registering device used to accumulate data over a period of

time and which must be read out periodically for billing or other purposes.

Thus, for example, the system 20 may be operable to effect periodic readout of register counters of a plurality of copying machines. Each register counter, such as register counter 21, has an encoder, such as encoder 31, associated therewith for converting dial readings of the register 21 into logic level data signals. The encoder is capable of providing a set of binary coded words which represent the current reading of the indicating device 21.

The copying machines may be located within the same building and the remote meter reading system 20 is thus operable to control the readout of all such machines within the building using existing electrical power lines of the building as a data transmission medium. The transponder units A1, A2, AN are connected to the control unit A over a common electrical power line 25 which is a branch of the existing power line circuit of the building in which the copying machines are located. The electrical power line 25 normally carries electrical power signals, such as 60 Hz, 120 VAC power signals.

Each of the transponder units A1, A2, AN is adapted to be plugged into an existing electrical outlet that is located in the proximity of the copying machine with which such transponder is associated. Thus, there is no need to provide a separate data transmission link between the transponders A1, A2, AN and the control unit A.

The control unit A provides interrogate signals for effecting the readout of a selected one of the indicating devices and the transponder of the selected indicating device provides reply data representing the reading of the selected indicating device. The interrogate data provided by the control unit A and the reply data provided by the transponders is transmitted over the power line 25 which interconnects the control unit A and the transponders A1, A2, AN.

Since the control unit A controls the readout of a plurality of data indicating devices, such as indicating devices 21—23 shown in Figure 1, each indicating device is assigned a multi-digit identification number or select code that is unique to that indicating device. The number of digits of the select codes is sufficiently large to enable an unique select code to be provided for each data indicating device to be read out under the control of the control unit A.

In a simplified illustration used to illustrate the operation of the system, each indicating device is assigned a different two digit select code. For exampl , indicating device 21 has been assigned select code 95, and indicating devices 22, 23 have been assigned select codes 96, 97, respectively. It is pointed out that while only three data indicating devices 21—23 are shown controlled by control unit A, this is for purposes of simplifying the discussion and any number of such devices can be controlled by a common control unit, such as control unit A.

The control unit A includes an interrogate signal generator 40, a converter 41, and a data receiver 42. The interrogate signal generator 40 provides logic level data signals representing the coding for the address of an indicating device to be read out. Thus, to select indicating device 21, the interrogate signal generator 40 provides an eight bit binary coded word representing the binary coding for the address 95 of the indicating device 21.

The converter 41 converts the data level signals provided by the interrogate signal generator 40 into frequency modulated signals for enabling the transmission of the select data to the transponders A1, A2, AN over the power line 25.

The converter 41 comprises a transmit section 45 including an FM modulator circuit 43 and a transmitter oscillator circuit 44, a receive section 49 including an amplifier limiter circuit 46 and a demodulator circuit 47, and a signal coupling network 48 which couples the output of the transmitter 44 and the input of the amplifier limiter circuit 46 to the power line 25. The signal coupling network 48 also serves to isolate the transmit section 45 from the receive section 49 of the converter 41.

The eight data bits provided by the interrogate signal generator 40 selectively energize the frequency modulator circuit 43 of the converter 41 which generates modulating signals of frequencies Fa and Fb, which may be 2KHz and 3KHz, respectively. Thus, a tone burst of frequency Fa is generated responsive to each logic 1 level bit and a tone burst of frequency Fb is generated responsive to each 0 level bit. The sequence of tone bursts Fa, Fb generated by the frequency modulator 43 are used to modulate a carrier signal F1, which may be 450 KHz, generated by the transmitter oscillator circuit 44 of the converter 41.

Frequency modulation is used for data transmission in the present system to provide a high signal-to-noise ratio in the presence of impulse noise signals which may be present on the power line 25 in addition to the 60 Hz, 120 VAC signals normally present on the power line 25.

Thus, in the present example, to effect readout of indicating device 21, the output of the transmitter oscillator 44 will be as shown in line A of Figure 2. The carrier frequency F1 is shown to be modulated by tone outputs of the modulator circuit 43 to

provide signals of a frequency F1 ± Fa to indicate each logic 1 level and signals of a frequency F1 ± Fb to indicate each logic 0 level. The series of frequency modulated signals thus provided by the transmitter 44 represent the binary coding for the address 95 of indicating device 21.

The frequency modulated carrier signals thus provided are coupled to the power line 25 over the signal coupling network 48 for transmission over the power line 25 to the transponders A1, A2, AN, at the remote location.

In accordance with one embodiment, the signal coupling network 48 is shown in Figure 3 to include a first bandpass filter network 50 having an inductor L1 and a pair of capacitors C1, C2, connected between the output of the transmitter oscillator 44 of the transmit section 45 of the converter 41 and a conductor 51 of the power line 25 over a capacitor C3. A second conductor 52 of the power line 25 is connected over a capacitor C4 to a point of reference potential or ground for the circuits of the converter 41.

The signal coupling network 48 further includes a second bandpass filter network 53 including an inductor L2 and a pair of capacitors C5, C6 connected between the input of the amplifier limiter circuit 46 of the receive section 49 of the converter 41 and the power line conductor 51 over capacitor C3. While in one embodiment the bandpass networks 50 and 53 are shown to be Pi filter nextworks, it is apparent that other types of bandpass filter networks could also be used.

The network 50 is tuned to a centre frequency of approximately 450 KHz, the frequency of the transmitter oscillator circuit 44. Thus, the frequency modulated signals generated by the transmitter oscillator 44 will be coupled to the power line 25 over the network 50 and capacitor C3.

In accordance with an exemplary embodiment, the remote reading system 20 employs full duplex operation to enable simultaneous transmission and reception of data signals between the control unit A and the tansponders A1, A2, . . ., AN at the remote location. Accordingly, as will be shown hereinafter, the transponders A1, A2 . . ., AN generate reply date at a frequency F2, which may be 500 KHz.

Therefore the bandpass filter network 53 connected to the receive section 49 of the converter 41 is tuned to a centre frequency of approximately 500 KHz to enable reply data signals present on the power line 25 to be coupled to the receive section 49 of the converter 41. The bandpass characteristics of the filter networks 50 and 53 provide isolation between the transmit and receive sections of the converter 41. The coupling capacitors C3 and C4 block the 60 Hz AC power signals on powerline 25 from entering the converter 41, but allow the 450 KHz signals to be coupled from the transmitter 45 to the power line 25 and the 500 KHz signals to be coupled from the power line 25 to the receiver 49.

It is pointed out that half-duplex or simplex operation could also be used in the remote meter reading system. In such case, the transmitter 44 of the control unit A and the transmitter 72 of the transponder A1, for example, would provide carrier signals of the same frequency. A clock pulse generator circuit, deriving its sync from incoming data signals, would alternate the transmit and receive functions of the control unit A and of the transponders A1, A2, AN, and thus, the isolation filters 50, 53 of the coupling networks 48, 62 would not be required.

The frequency modulated carrier signals generated by control unit A are transmitted over the power line 25 to all of the transponders A1, A2, AN which are connected to the power line 25. Each transponder, such as transponder A1 associated with indicating device 21, includes a converter 60 and associated control logic circuits 61.

Each converter, such as converter 60, comprises a receive section 63 including an amplifier limiter circuit 64, a demodulator 65, a pair of tone filters 66, 67 and a pair of tone detector circuits 68, 69, a transmit section 70 including an FM modulator circuit 71 and a transmitter oscillator circuit 72, and a signal coupling network 62 which couples the transmit and receive sections to the power line 25.

The signal coupling network 62 is similar to the signal coupling network 48 shown in Figure 3. However, the Pi filter network 53 which is connected between the power line 25 and the receive section 63 of the transponder A1 is tuned to a centre frequency of approximately 450 KHz, the frequency of the interrogate signals provided by the control unit A. Moreover, the Pi filter network 50 which is connected between the power line and the transmit section 70 of the transponder A1 is tuned to a centre frequency of approximately 500 KHz which is the frequency of signals provided by the transmitter oscillator circuit 72. The capacitors C3, C4 block the 60 Hz AC signals normally present on the power line 25 from entering the transponder converter 60.

The frequency modulated signals received at the transponder A1 are extended to the demodulator circuit 65 over the signal coupling network 62 and the amplifier limiter circuit 64. The demodulator circuit 65 removes the intelligence (Fa and Fb) from the carrier F1 and provid s output

tones of frequencies of 2KHz (Fa) and 3KHz (Fb) representing logic 1 and logic 0 levels, respectively, in a sequence coded to represent the address of the selected indicating device 21.

The tone sequence representing the select code transmitted from control unit A is extended to the inputs of tone filters 66 and 67 which serve as a separation network. Tone filter 66 is tuned to detect tones of a frequency of 2KHz, and tone filter 67 is tuned to detect tones of a frequency of 3KHz. The outputs of the tone filters 66 and 67 are extended to tone detecting circuits 68 and 69, respectively, which provide outputs representing logic 1 and logic 0 levels, respectively. Thus, as indicated in line B of Figure 2, responsive to each carrier signal modulated by a 2KHz tone, detector circuit 68 will provide an output representing a logic 1 level and responsive to each carrier signal modulated by a 3KHz tone, detector circuit 69 will provide an output representing a logic 0 level. The logic level outputs of the receive section 63 of the converter 60 are extended to the logic circuits 61 of the converter.

The logic circuits 61 include a clock circuit 74, a select code comparator circuit 75, a data register 76 and a transfer enable circuit 77.

The output of the tone detector 68 is extended to a data input 78 of the data register 76. The data register may comprise a multi-stage shift register having a number of stages equal to the number of bits that comprise the select code, which in the exemplary embodiment is eight.

Since the signal outputs of the tone detector circuits 68 and 69 are complementary, only the signal outputs of tone detector 68 are extended to the data regiser 76. Thus, as each bit of the select data is received and detected by the receive section 63 of transponder A1, a sequence of logic bits representing the binary coding for the address transmitted from the control unit A will be extended to the data register 76.

The outputs of the tone detectors 68 and 69 are extended to inputs 79, 80, respectiv ly, of the clock circuit 74. The clock circuit 74 has an output connected to a clock input 81 of the data register 76.

The clock circuit 74 is responsive to each logic level signal output provided by the detector circuits 68, 69, to provide a clock pulse for controlling the entry of each bit of the bit sequence representing th sel ct code into the data register 76.

When all eight select bits have be n clocked into the data register 76, th code comparator circuit 75 is effective to compare the received select or address code with an address code stored by the code comparator circuit 75.

Whenever each bit of the select code stored in the data register 76 is the same as a corresponding bit of the address code stored by the code comparator circuit 75, the code comparator circuit provides enabling outputs for the data transfer circuit 77 and the transmitter oscillator circuit 72 of the transponder A1.

It is pointed out that the transmitter oscillator circuit 72 of transponder A1 is normally unenergized and the code comparator circuit 75 provides an enabling signal to effect energization of the circuit 72 only when the indicating device 21 associated with such transponder is selected to be read out.

The data transfer circuit 77, when enabled by the code comparator circuit 75, is operable to effect the transfer of the logic level data signals which represent the reading of indicating device 21 from the encoder 31 to the data register 76. In the exemplary example, it is assumed that the indicating device 21 includes a two dial register providing a two digit reading and that the associated encoder 31 provides an eight bit binary coded word representing the reading of the register 21. Accordingly, the data transfer circuits 77 are responsive to the enabling signal provided by the comparator circuit 75 to effect the transfer of the eight bit word provided by the encoder into the data register 76.

After the select signals have been received at transponder A1 and the reading data has been transferred to the data register 76, the control unit A generates readout signals for effecting the readout of the data provided by indicating device 21 at the remote location. The eight bit data word stored in the data register 76 is read out bit-by-bit under the control of the control unit A. The interrogate signal generator 40 of control unit A provides a series of eight logic 1 level bits for controlling the FM modulator 43 and the transmitter oscillator 44 to provide the series of readout signals (450 KHz carrier signals modulated by 2KHz signals) shown in line A of Figure 2.

The readout signals generated by the transmitter oscillator 44 are coupled to the power line 25 over the coupling network 48 and transmitted to all transponders A1, A2, AN connected to the power line 25. It is pointed out, however, that only transponder A1 of the selected indicating device 21 is responsive to th readout signals to nable transmission of data back to the control unit A.

The frequency modulated readout signals transmitted to the transpond r A1, A2, AN over the pow r line 25 are coupled ov r associated coupling networks, such as coupling network 62, to th receive sections of the transponders, such as receiv section

63 of transponder A1. The readout signals are passed through the amplifier limiter circuit 64 and the demodulator circuit 65 which removes the modulating tones at a frequency of 2KHz from the 450 KHz carrier signal. The 2KHz tones, representing logic 1 data bits, are extended to the tone filter 66 and tone detector 68 which provides the series of logic 1 level bits shown in line B of Figure 2.

The logic level readout data bits thus provided are extended to the data input 78 of the shift register 76 to effect serial readout, under the control of the clock pulses provided on line 81, of the data stored in the data register 76 representing the reading of indicating device 21. The readout data bits provided at the output of the tone detector 68 are also extended to the clock circuit 74 which provides clock pulses for enabling the entry of each readout data bit into the input stage of the shift register 76.

As the readout bits are shifted into the data register 76 one at a time, the data bits representing the reading of the indicating device 21 are shifted out of the data register 76, providing a sequence of logic 1 and logic 0 bits coded to represent the reading.

The sequence of logic 1 and logic 0 data bits provided at the output of the data register 76 is extended to the frequency modulator circuit 71 which is responsive to each logic 1 level bit to provide modulating signals of a first frequency Fa, which may be 2KHz, and responsive to each logic 0 level bit to provide signals of a second frequency Fb, which may be 3KHz. The modulating signals in turn control the transmitter oscillator circuit 72 modulating the carrier frequency F2, which may be 500 KHz, provided by transmitter 72 to generate frequency modulated signals coded to represent the reading of the indicating device 21.

Thus, by way of example, assuming the reading of the indicating device 21 is sixty-seven, the transmitter 72 will provide the series of frequency modulated signals indicated on line C of Figure 2 consisting of the transponder carrier frequency F2 modulated by signals of frequencies Fa and Fb. The reply data signals generated by the transmitter oscillator circuit 72 are coupled to the power line 25 over the signal coupling network 62 and transmitted over the power line 25 back to the control unit A.

The reply data signals received at the control unit A are coupled over the signal coupling network 48 to the input of the receive section 49 of the control unit A.

The received signals are coupled over coupling network 48 to the amplifier limiter circuit 46 and the demodulator 47 where the modulating signals Fa, Fb are removed from the transponder carrier signal F2. The recovered signals Fa, Fb are then passed to a tone filter and detector circuit 47 which provides a logic 1 level output for each signal of frequency Fa. The output of the receiver section 49 of the control unit A, shown in line D of Figure 2 comprises a sequence of logic level signals representing the binary coding for the reading 67 of indicating device 21. The binary coded reading data is passed to the data receiver circuit 42 of the control unit A where the received data is stored.

The readout of the indicating devices 21—23 of the system 20 shown in Figure 1, as well as the readout of a plurality of groups of other indicating devices at a plurality of other locations, can be controlled from a central interrogate station. Thus, referring to Figure 4, an interrogate unit 120 at a central interrogate station provides interrogate signals for transmission to the locations of indicating devices 21—23 which may be associated with equipment in a first building A and further interrogate signals for transmission to the location of other indicating devices 121—123 which may be associated with equipment in a second building B at a location remote from the first building A.

The interrogate signals transmitted to the locations of indicating devices 21—23, 121—123 are received at respective control units A, B and transmitted to corresponding transponders A1, A2, AN, or B1, B2, BN over existing electrical power lines 25, 125 of the buildings within which the indicating devices 21—23, 121—123 are located.

The control units, such as control unit A, serve as exit data transponders operable to transmit the reading data provided by each of the indicating devices 21—23 at a plurality of different locations in the building A to the central interrogate station from a signal control location in the building A.

The interrogate signals provided by the interrogate unit 120 may be transmitted to a control unit associated with a group of indicating devices via an RF communication link established between the interrogate unit 120 and a control unit, such as control unit A. Alternatively, the interrogate signals may be transmitted over a direct communication link established over a telephone line 150 connected between the interrogate unit 120 and a control unit, such as control unit B.

Thus, in one arrangement for controlling the readout of indicating devices 21—23 associated with control unit A, the interrogate unit 120 includes an RF transmitter 161 controlled by the data processing unit 160 to generate RF interrogate signals, including select signals coded to represent the address of one of the indicating devices 21—23 selected to be read out, and readout

signals for effecting the readout of the reply data provided by the selected indicating device. The interrogate signals are coupled over a coupling network 162 to an antenna 163 of the interrogate unit 120 for transmission to the location of the control unit A. It is pointed out that the interrogate unit 120 may be a mobile unit, such as mobile interrogate unit 120 shown in Figure 4a, which is driven in the vicinity of the buildings, such as building A, in which the data indicating devices 21—23 are located.

Control unit A includes an RF transponder 140 having an antenna 164 for receiving the interrogate signals transmitted from the interrogate unit 120. The received RF signals are coupled over a coupling network 166 to a receiver-detector circuit 165 of the transponder 140. The receiver-detector circuit 165 converts the RF signals into a series of data pulses coded to represent the select and readout data.

The control unit A further includes a converter 41 having an FM transmitter 45 which converts the data pulses provided by the RF transponder 140 into frequency modulated signals for transmission over the electrical power line 25 of building A to the transponders A1, A2, AN connected to the power line 25. In addition, the converter 41 of control unit A includes an FM receiver 49 which receives frequency modulated reply signals provided by the transponder of a selected indicating device and converts such received signals into data pulses representing the reading of a selected indicating device. The operation of the converter 41 has been set forth in the foregoing description with reference to Figure 1.

The reply data pulses are passed to the RF transponder 140 which further includes an RF transmitter 167 which is responsive to the logic level pulses to generate RF reply signals coded to represent reading of the selected indicating device for transmission to the central interrogate station 120.

The central interrogate station 120 further includes an RF receiver 168 which receives the RF reply signals and converts the received signals to logic level data for processing by the data processor 160 of the interrogate unit 120.

One RF system for transmitting RF interrogate signals from a central location to a remote location for effecting the readout of a plurality of data indicating devices is described in our U.S. Patent No. 3 705 385. The mobile unit shown in the U.S. patent could serve as the mobile unit 120 shown in Figure 4a, and the transponder of the U.S. Patent could be used as the RF transponder 140 in the present system with the signal outputs of the tone detector 50 being used to control the FM transmitter 45 shown in Figure 5 and reply data being transmitted by a locked oscillator and quenching modulator such as are shown in the U.S. patent.

Alternatively, in a second arrangement for controlling the readout of indicating devices 121—123 associated with the control unit B, interrogate unit 120 is connected directly to control unit B at a remote location over the telephone line 150. In such application, the interrogate unit 120 includes a tone generator 171 which is controlled by the data processor 160 to generate multi-frequency tone signals coded to represent the address of a selected indicating device and readout signals for effecting the readout of the selected indicating device. The multi-frequency selected readout signals are coupled to the telephone line 150 over a coupling network 172 for transmission to the location of control unit B.

Control unit B includes a tone receiving unit which may comprise a data set 151 which includes a tone receiver 173 which receives multi-frequency signals coupled thereto over line coupling network 174 from the communication line 150 and converts the multi-frequency signals into binary coded pulses representing the select and readout data.

Control unit B also includes a converter 141 which is similar to converter 41 of control unit A. Converter 141 converts the binary pulses provided by the data set 151 into frequency modulated signals representing the select and readout data. Converter 141 is connected to power line 125 to enable the frequency modulated signals provided by the converter 141 to be transmitted over power line 125 to the transponders B1, B2, BN which are connected to power line 125. Whenever one of the indicating devices 121—123, such as indicating device 121, is selected to be read out, the associated transponder B1 is responsive to the select and readout signals present on line 125 to provide frequency modulated reply data signals representing the reading of the selected indicating device 121.

The frequency modulated reply signals generated by transponder B1 are transmitted over power line 125 to a converter 141 of the control unit B which converts the frequency modulated signals to a train of data pulses representing the reading indicated by the reply data received. The data pulses are passed to a tone generator 175 of data set 151 for controlling the tone generator 175 to effect the generation of multi-frequency signals which are coded to represent the reading of indicating device 121. The multi-frequency signals thus generated are coupled to the com-

munication line 150 over the line coupling network 174 and are transmitted back to the interrogate unit 120 at the central interrogate station.

The central interrogate unit 120 further includes a multi-frequency tone receiver 176 which receives signals coupled thereto from the communication line 150 over coupling network 172. The tone receiver 176 converts the multi-frequency tones into logic level pulses which are passed to the data processing unit.

WHAT WE CLAIM IS:—

1. A system for effecting selective readout of data from a plurality of data indicating devices disposed at respective different locations, comprising interrogate means for generating interrogation signals selectively coded in accordance with a selected one of the data indicating devices which is to be read out, control means disposed at a control location and including a first means responsive to the interrogation signals to provide control signals for effecting the readout of a selected indicating device and signal coupling means for coupling the control signals to an electrical power supply line, and a plurality of transponders each connected to the power supply line and to a respective one of the data indicating devices, the transponders each being responsive to receipt of control signals coded to select the associated data indicating device to apply to the power supply line, for transmission to the control location, data signals representing a readout of the device, the control means including a second means responsive to said data signals to generate reply signals representing the readout for transmission to the interrogate means.

2. A system as claimed in claim 1, wherein the interrogate means is disposed at the control location.

3. A system as claimed in claim 1, wherein the interrogate means is disposed at a central interrogate station remote from the control location, the interrogation and reply signals being transmitted between the interrogate means and the control means by way of a communications link.

4. A system as claimed in claim 3, wherein the communications link is a radio communications link.

5. A system as claimed in claim 4, including means for converting the interrogation signals and reply signals from binary digital form to radio frequency form prior to transmission over the link and means for converting the signals back to binary digital form after transmission over the link.

. A system as claimed in claim 4 or 5, wherein the interrogate means is disposed at a mobile central interrogate station.

7. A system as claimed in claim 3, wherein the communications link is a line.

8. A system as claimed in claim 7, including means for converting the interrogation and reply signals from binary digital form to multi-frequency form prior to transmission over the line and means for converting the signals back to binary digital form after transmission over the line.

9. A system as claimed in any of claims 3 to 8, including a plurality of said control means each disposed at a respective one of a plurality of control locations, the interrogate means being connected with each of the control means by a respective one of a plurality of communication links.

10. A system as claimed in any preceding claim, wherein the data indicating devices connected to the or each of the control means are disposed at locations which are all within a single building.

11. A system as claimed in any preceding claim, wherein the interrogation signals comprise a select group of signals for selecting a particular data indicating device and a subsequent readout group of signals for effecting transmission of the data signals from the selected device.

12. A system as claimed in any preceding claim, wherein the control means and each of the transponders includes a frequency modulator for converting the control signals and the data signals from binary digital form to frequency modulated form before application to the power supply line, and a demodulator for converting the signals back to a binary digital form on receipt.

13. A system as claimed in claim 12, wherein the control means and each of the transponders includes a carrier frequency oscillator, the output of which is applied to the power supply line after modulation by the output from the associated frequency modulator.

14. A system as claimed in claim 13, wherein the frequency of the control means oscillator is different from that of the transponder oscillators and each of the control means and the transponders is connected to the power supply line by means of a respective coupling network which includes a pair of band pass filters tuned to centre frequencies corresponding to the respective carrier frequencies.

15. A system for effecting selective readout of data from a plurality of data indicating devices disposed at respective different locations, substantially as herein described with reference to the accompanying drawings.

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Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1975.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1400477 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

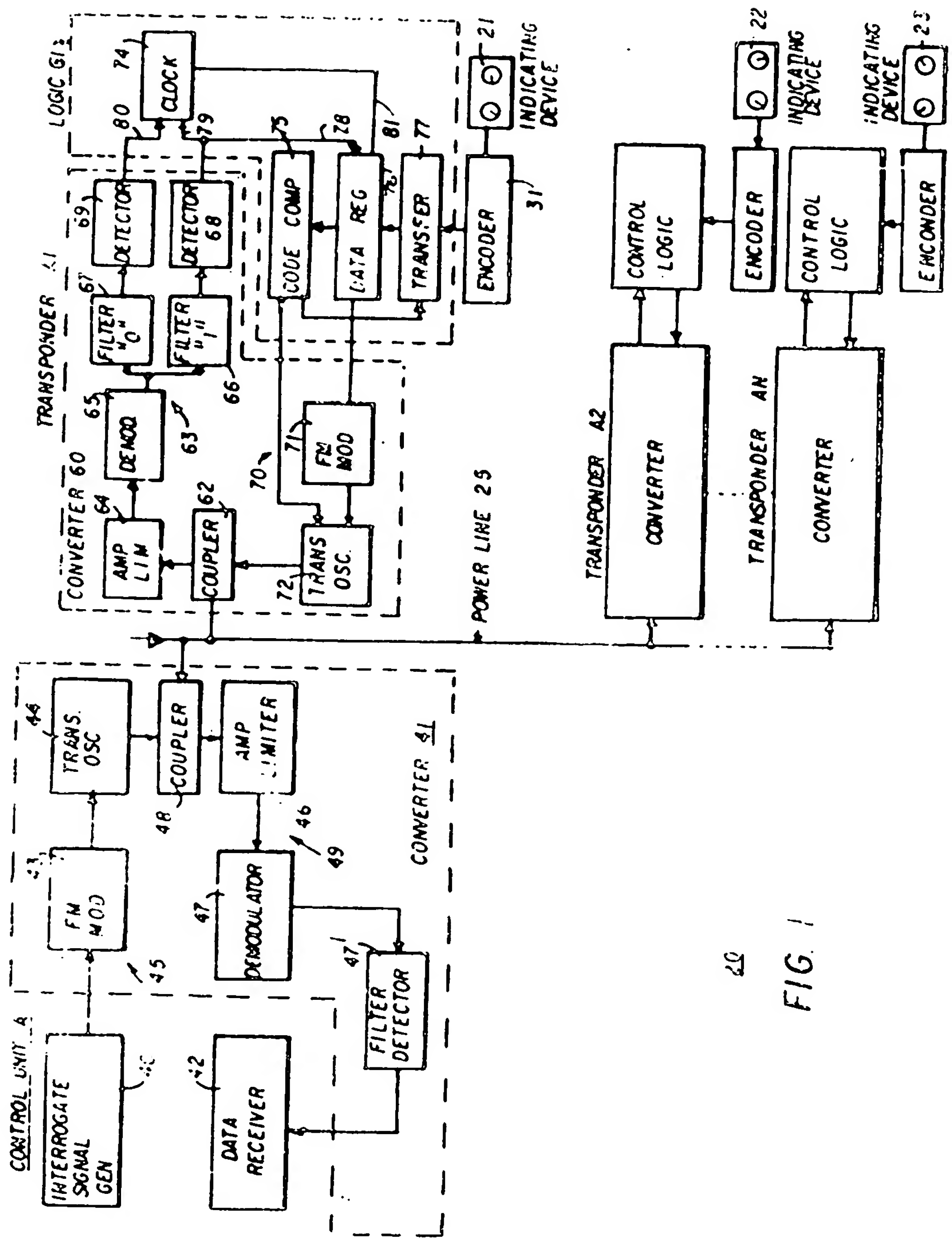


FIG 1

1400477 COMPLETE SPECIFICATION

4 SHEETS This drawing is a reproduction of the Original on a reduced scale

Sheet 2

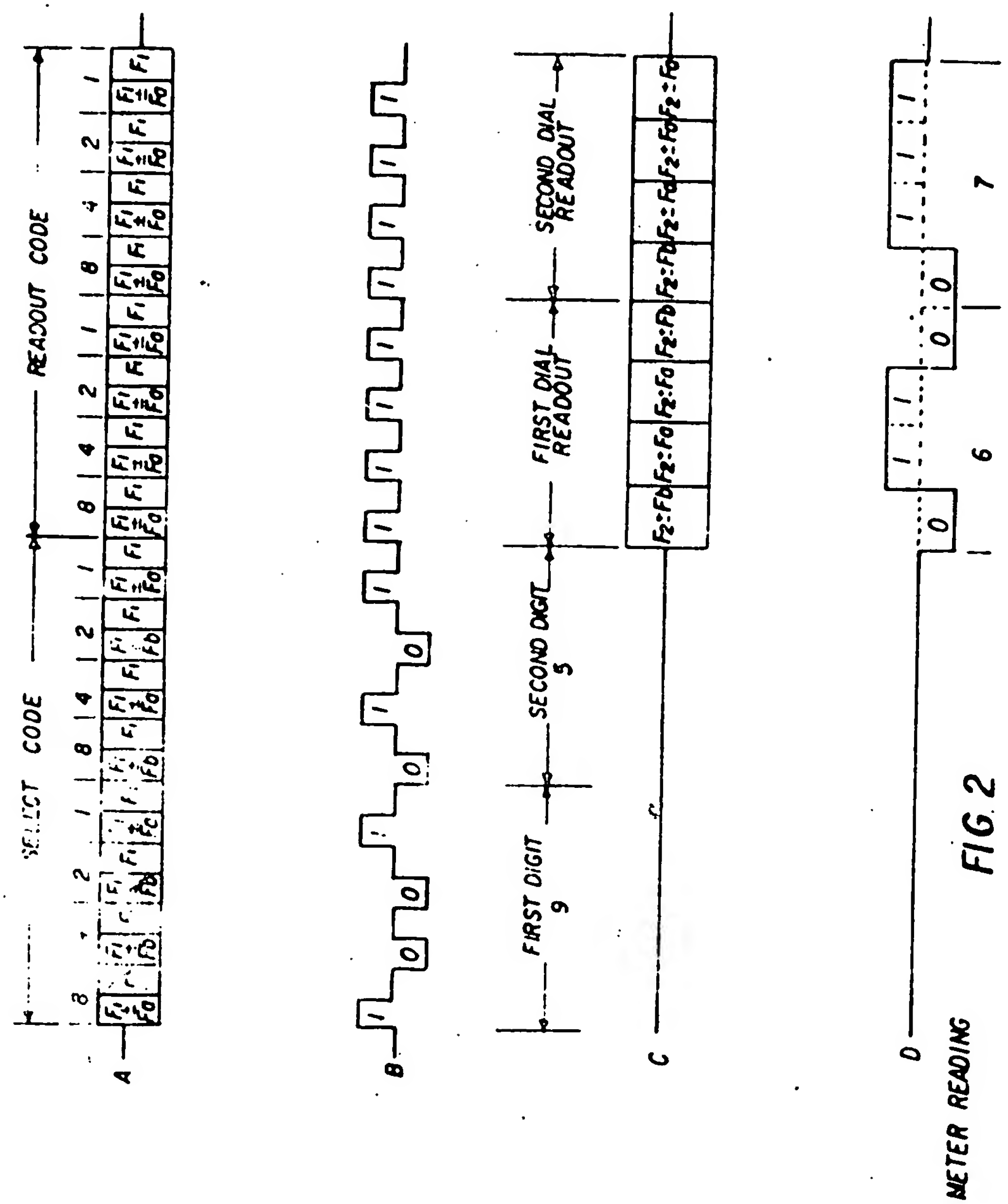


FIG 2

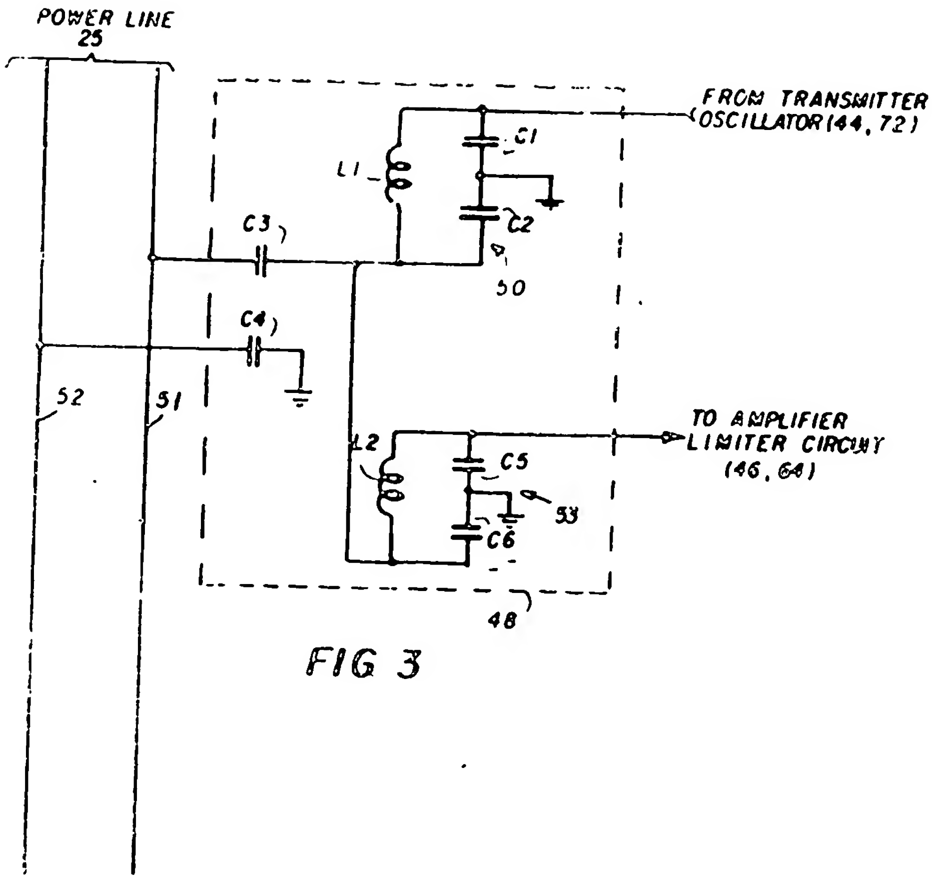
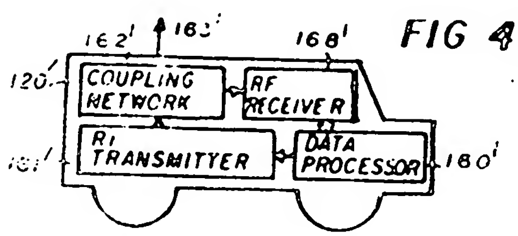

POWER LINE
25
FROM TRANSMITTER
OSCILLATOR (44, 72)
C1
L1
C2
C3
50
C4
52
51
L2
C5
53
C6
TO AMPLIFIER
LIMITER CIRCUIT
(46, 64)
48

FIG 3

FIG 4A


162'
168'
120'
COUPLING
NETWORK
RF
RECEIVER
R1
TRANSMITTER
DATA
PROCESSOR
180'

1400477 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 4

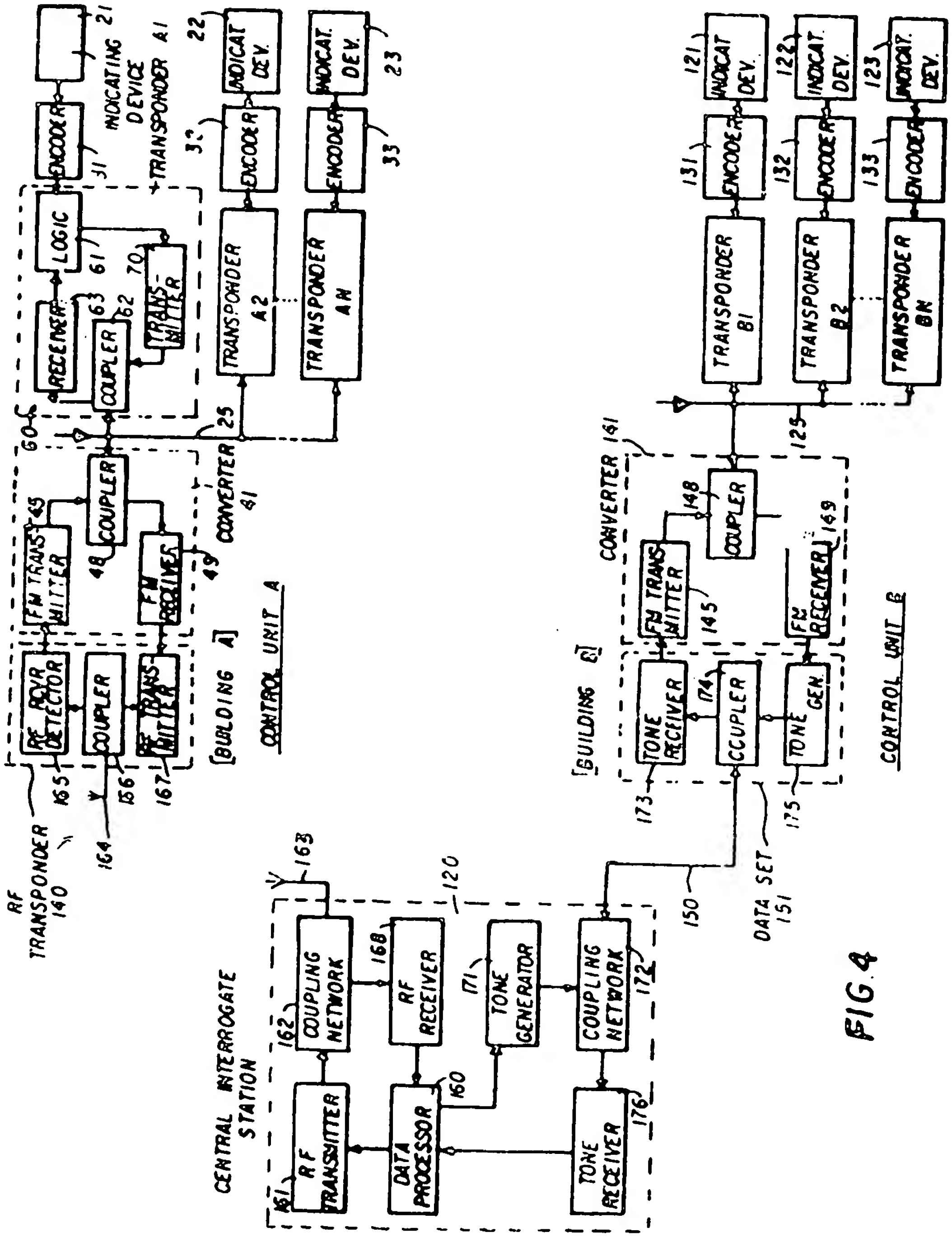


FIG 4